Wild Beans of the Greater Southwest: *Phaseolus metcalfei* and *P. ritensis*[1]

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Cocolmeca (the Phaseolus metcalfei *group) are leguminous root perennials of the uplands (1,000–2,500 m elevation) of southwestern North America. Their cultural significance has been underestimated both within and beyond their natural range, where they have been utilized in prehistoric and historic times. Ambiguities in both scientific taxonomy and folk taxonomy obscure the fact that both* P. metcalfei *and* P. ritensis *have been widely used as systemic medicine, food, in fermentation, as forage, and as glue. The use of the seeds as green and dried bean foods was historically extensive, but was abandoned due to changes in Indian subsistence patterns and in the availability of the plants themselves. Herb dealers today are responsible for transport of the roots as far north as the Navajo in Utah; it is suggested that cross-cultural merchants may have been responsible for their diffusion historically or even prehistorically. Bean seed from the two species contain 20.5–30.9% crude protein. Germ plasm conservation and screening are needed in order to evaluate further the potential of these species as cultivated food and forage crops for semiarid uplands.*

Tropical and subtropical legumes with underexploited potential have recently been given the attention they deserve (United States National Academy of Sciences, 1979). Yet so little has been written about certain economic legume species—though they may have been utilized for millenia—that their historic importance and potential remain underestimated. The value of *Phaseolus metcalfei* and *P. ritensis* have been obscured historically, since their populations had been diminished, and natives which utilized them had their transhumant subsistence activities disrupted. As an example of "salvage ethnobotany," we have pieced together clues to the former economic importance of these native, multiproduct plants (Fig. 1). In addition, the first chemical analyses of these plants have been completed, using field collections of *P. metcalfei* and *P. ritensis* from the northern fringes of their geographic range.

BIOSYSTEMATICS

In a taxonomic monograph of the legume tribe Phaseolineae, Piper (1926) describes one group of species as "*Phaseolus metcalfei* and its close relatives." The name *P. retusus* Benth. not Moench. had been formerly utilized for all four species in this group; it is an incorrect synonym, or *nomum confusum*. Piper characterizes these related species as perennials with deep woody roots; somewhat leathery, veined leaflets; red-purple flowers; and broad, compressed bean pods. Two of these species, *P. metcalfei* Woot. and Standl., and *P. ritensis* Jones, have been found in southwestern North America (Fig. 2).

Piper (1926) suggested that *P. ritensis* is a "hardly distinct species," replacing

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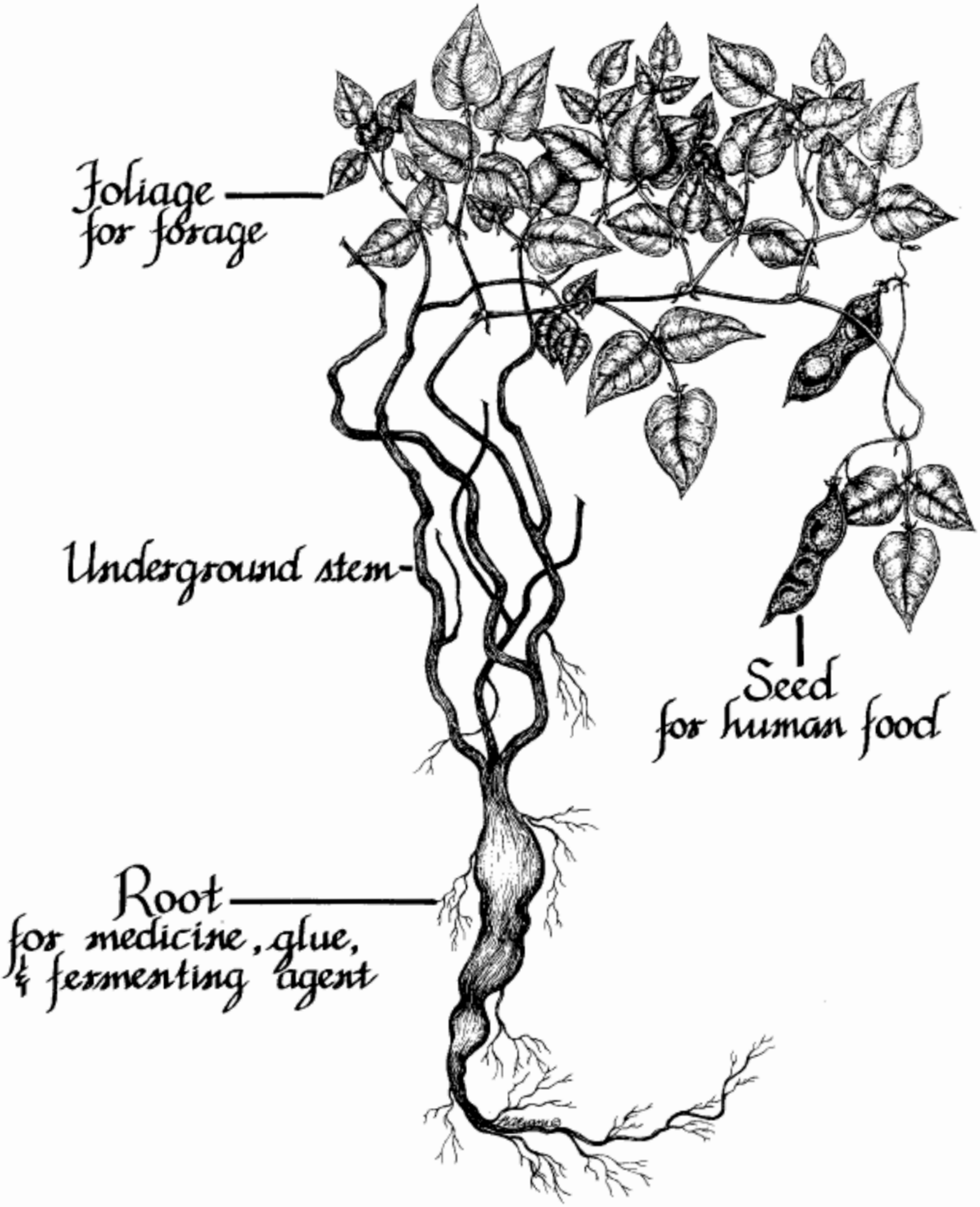

Fig. 1. Drawing of *Phaseolus metcalfei*, showing source of useful plant products.

in Arizona the more widespread *P. metcalfei*. Others have argued the geographic limits and taxonomic validity of these two taxa. Goodding (1946) reported that the two species grow together in the same wash in Sycamore Canyon on the Arizona-Sonora border, although only his *P. ritensis* specimens from this locality are available. In *Arizona Flora* (Kearney and Peebles, 1960), these two taxa are considered to be "perhaps only varietally distinct," and both are noted as occurring in southern Arizona. Recently, Marechal et al. (1978) examined a limited

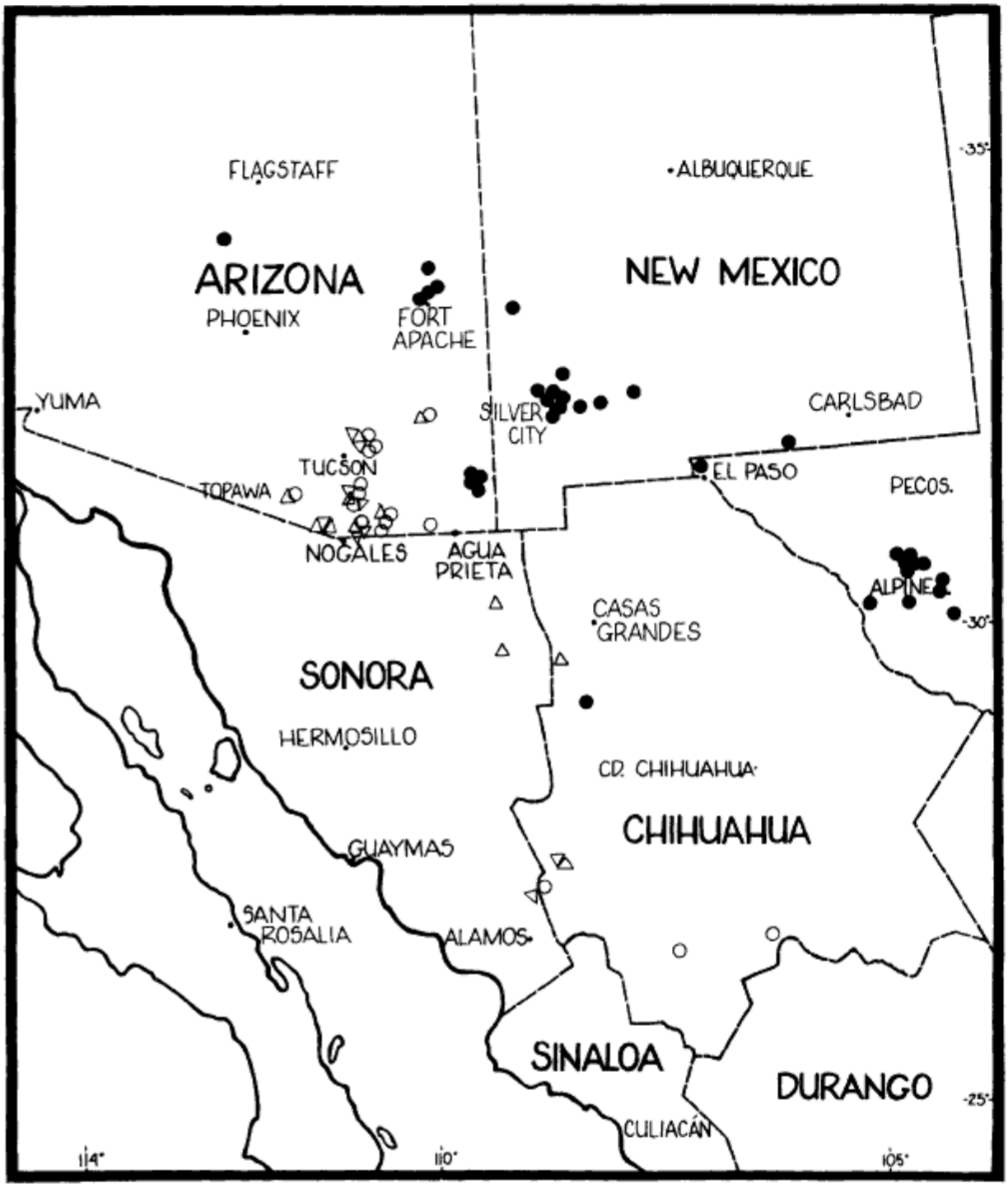

Fig. 2. Map showing the distributions of *Phaseolus metcalfei* and *P. ritensis* in southwestern North America, based on available herbaria specimens. Legend: ● = *P. metcalfei*; △ = *P. ritensis*; ○ = uncertain.

number of herbaria specimens and decided that the distinction between the two taxa had little merit. They assigned all specimens to *P. ritensis* Jones, since this is the earliest valid name. This controversy has led us to a more thorough examination of the diagnostic characters noted in the literature (Table 1), and of a greater range of herbaria specimens (Table 2). Our measurements of specimens indicate that certain phenetic characters utilized in the taxonomic literature for distinguishing the two species are not consistently diagnostic. On the other hand, there are numerous specimens, with markedly lesser weight and size (particularly, breadth) of their seeds, which we distinguish as *P. ritensis*.

TABLE 1. COMPARISON OF *Phaseolus metcalfei* AND *P. ritensis*.[a]

Character	*P. metcalfei*	*P. ritensis*
Leaf shape[b]	Broadly ovate, rhombic, obovate, to rhombic	Ovate to broadly rhombic ovate
Peduncles	1–2 dm long	up to 6 dm long
Calyx length	5 mm	2–3 mm
Bract length[b]	0.5–1 mm, persistent	minute, deciduous
Bractlets[b]	1.5 mm or longer; linear	1 mm or shorter; lanceolate
Pod-calyx juncture[b]	Sessile	Falcate; short to long stipitate
Pod width	5–18 mm	4–10 mm
Pod length	35–80 mm	30–40 mm

[a] From Jones, 1908; Shreve and Wiggins, 1964; Correll and Johnston, 1970; Piper, 1926.
[b] Indicates character of doubtful significance in identifying specimens of these species.

Until genetic and chemotaxonomic data are gathered from a variety of populations, we feel that these two taxa should be maintained as apparent sibling species. A successful cross between *P. vulgaris* and *P. ritensis* has been engineered with the aid of embryo culture (Braak and Kooistra, 1975). Marechal et al. (1978) also report a successful cross of *P. lunatus* and *P. ritensis* (sensu lato) made by French geneticists. These artificial crosses resulted in wide hybrids, and do not indicate a close genetic relationship between *P. ritensis* and the domesticated species of *Phaseolus*. The germ plasm utilized was *P. metcalfei* (sensu stricto).

Unless otherwise indicated, we will refer to *P. ritensis* and *P. metcalfei* as "the *P. metcalfei* group," or by their common folk name, cocolmeca, for the purposes of discussion. These terms are not only expedient; they reflect the common uses and natural history which these taxa share (Goodding, 1938).

NATURAL HISTORY AND PRODUCTIVITY

In terms of growth habit and survival strategy, *Phaseolus metcalfei* functions as a perennial ephemeroid (after Noy-Meir, 1973), as do many other arid land

TABLE 2. NEW EXAMINATION OF *Phaseolus metcalfei* AND *P. ritensis*.

	P. metcalfei	*P. ritensis*
Position of leaf at second node[a]	Petiolate	Sessile
Morphology of leaf at third node[a]	Trifoliate	Unifoliate
Calyx length	3–5 mm	1.6–4 mm
Pod dehiscence	Weakly dehiscent, hardly curling	Strongly dehiscent, violently twisting
Pod width	9–18 mm	6–10 mm
Pod length	38–59 mm	24–45 mm
Seed length[b]	9.2 ± 1.3 mm	7.5 ± 0.6 mm
Seed width[b]	7.9 ± 0.8 mm	5.1 ± 0.5 mm
Seed breadth[b]	5.8 ± 0.6 mm	2.5 ± 0.3 mm

[a] Observations by Russ Buhrow, Plant Sciences, University of Arizona, and Daniel Debouck, Centro Internacional de Agricultura Tropical, Columbia.
[b] Measurements for 75 seed from each species (three populations each), expressed as mean and range at one standard deviation.

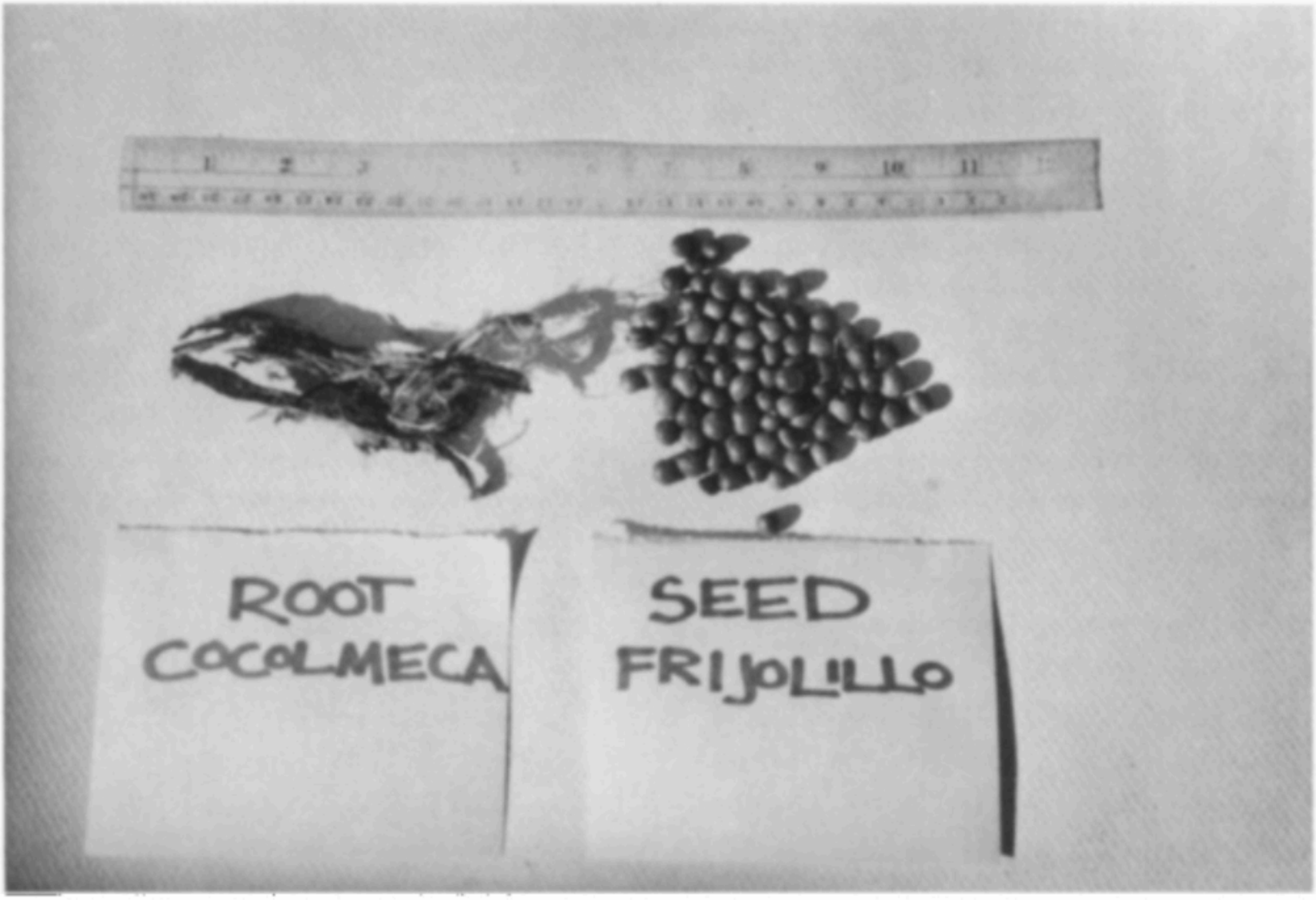

Fig. 3. The two major plant products of *Phaseolus metcalfei* are known by their different folk names, cocolmeca and frijolillo.

plants. These plants are characterized by large underground storage organs which briefly send out vegetative shoots when conditions become least arid. In the Southwest, this atypically mesic period is generally during the short monsoon season of late summer, when humidity and soil moisture often remain high for several weeks. Solbrig et al. (1977) consider plants which lie dormant as roots during dry periods to be more vulnerable to long droughts than seeds, since their reserves are depleted more easily.

The taproots of perennial ephemeroids contain water reserves, and often store substantial amounts of carbohydrates and proteins. These reserves allow rapid growth with the first signal of the rainy season, and flowering can begin independent of rainfall. Unlike those in ephemeral herbs, energy flows can be partially reversed back into storage organs if rains fail, or can be reactivated if optimal conditions arrive tardily (Noy-Meir, 1973).

P. metcalfei and *P. ritensis* taproots are as much as 1 m long and 8 cm in diameter, beginning 5–50 cm below the soil surface (Fig. 1). In the Sonoran Desert, the timing of new stem and leaf growth appears to be more tightly tied to the late summer rains than elsewhere. In Trans-Pecos Texas, for instance, flowering specimens have been collected in June (Warnock W-819, UT!; Turner 1955, SRSC!). In 1977, we found Texas populations (e.g., Nabhan 688, ARIZ) fruiting 3–5 weeks earlier than those in Arizona and New Mexico.

Once photosynthetic and flowering activities are initiated, fruiting quickly follows. In a *P. ritensis* population near Sycamore Canyon, Arizona, pods had not yet set by 31 July 1977, although flowers were open for pollination (Nabhan 661a, ARIZ). By 4 September, the population was near the peak of its fruiting period,

with beans filled out in many of the pods. By 19 October, all of the pods had become inactive and had begun to deteriorate not long after fruiting, well in advance of killing frosts. This *P. ritensis* population included about 50 plants within a 10 m × 10 m area. The most prolific *P. metcalfei* population which we had sampled also had about 50 plants per 10 m², and yielded 54.8 g of recoverable seed (beans). This yield figure does not include the many seeds which had already fallen out of dried pods by 8 October (Fig. 4).

Projecting from this yield figure, we estimate that 5–10 kg of seed could be harvested per hectare of wild *P. metcalfei,* provided that the population was harvested near the peak fruiting time prior to pod dehiscence. This estimate falls well below the 20 kg/ha seed yield for wild teparies (*Phaseolus acutifolius*) (Nabhan and Felger, 1978). However, from a gatherer's viewpoint, *P. metcalfei* beans are much easier to harvest. *P. metcalfei* pods are in clumps on racemose inflorescences which project above the foliage, whereas *P. acutifolius* pods occur singly along vines twining into shrubs and trees. In addition, *P. acutifolius* pods dehisce explosively, propelling the beans out in various directions. *P. metcalfei* pods retain their beans longer, and then drop them to the soil adjacent to the plant. Having larger seeds than any other wild *Phaseolus* in the Southwest, *P. metcalfei* was probably most attractive to gatherers despite its lower yield per area. However, the seeds are vulnerable to both rodents (Goodding, 1946) and bruchid beetles.

Productive populations of *P. metcalfei* and *P. ritensis* in the northern portions of their range, are generally on steep, north-facing rocky slopes, between 1,200 and 2,100 m elevation (Fig. 2). Marginal populations may occur as low as 1,000 m and at least as high as 2,500 m. Mean annual rainfall within their usual elevational range probably reaches as low as 40 cm and as high as 100 cm.

In the contemporary Southwest, such physical environments are occupied by pine-dominated vegetation at higher elevations, and juniper, oak or chaparral vegetation below. *P. metcalfei* has also been associated with grasslands historically (Harvard, 1885). This association will be discussed later.

The geographic ranges of these two species appear to overlap only in a few mountain ranges (Fig. 2). *P. ritensis* occurs in the island-like ranges of southern Arizona, east from the Baboquivaris to the Huachucas. It also ranges southeastward into the Rio Bavispe and Sierra Madre of Mexico. *P. metcalfei* stretches northward almost to the Colorado Plateau along the Mogollon Rim, and southward, presumably on both sides of the Sierra Madre Occidental. The Patagonia, Santa Rita and Chiricahua Mountains should be explored for areas where these species occur sympatrically or introgress.

FOLK TAXONOMY

The native terminology for plants is not simply linguistic trivia; it provides clues to the origin and spread of the knowledge regarding valuable plants (De Candolle, 1959). The term cocolmeca is the most extensively used name for *Phaseolus* roots, yet is also applied to several other plants. Although of pre-Columbian origin in Mexico, there are alternative hypotheses regarding the specific Indian language from which it is derived, and to which plant it was originally applied.

Fig. 4. A prolific *Phaseolus metcalfei* population on steep rocky outcrops near Pinos Altos, north of Silver City, New Mexico.

Fig. 5. Cocolmeca, as sold in Sonora, Mexico markets "for reducing weight without dieting."

Fig. 6. A travelling herbalist selling cocolmeca and other herbs at the Magdelena fiesta, Sonora, Mexico, in October 1977.

Fig. 7. Cocolmeca roots (foreground, left) among other herbs sold to Indians and mestizos in Magdelena, Sonora.

In addition to its widespread use for *Phaseolus* roots in northern Mexico, the term is used by herbalists for the following species: *Salix mexicana*, in Zacatecas (Riley and Trujillo, 1956); the genus *Smilax* in central Mexico (Gallo, 1926; Martinez, 1969; Winter, 1978); and for two composites, *Eupatorium quandrangulare* and *Milleria quinqueflora* in the Rio Mayo of Sonora and Chihuahua (Gentry, 1942).

Although the multiple use of this one term for several plants causes confusion, the general usefulness of calling the *P. metcalfei* group cocolmeca in southwestern North America can be defended. Of all the samples tagged cocolmeca in herbstands throughout Arizona, Sonora and Chihuahua, we have examined only one that is not definitely a *Phaseolus* root (in Juarez, Chihuahua). It appears that *Phaseolus* roots are most frequently called cocolmeca in northern Mexico. Today, however, some educated herb vendors, who utilize *Las Plantas Medicinales de Mexico* (Martinez, 1969) for information, assume that they are selling *Smilax* roots even though they are vending *Phaseolus*!

Several different derivations of the term cocolmeca are suggested. The first implies that the term was originally applied to *Smilax* species farther south in Mexico, and later, to other plants with red roots. An Aztec dictionary affirms that the term cocolmeca is Hispanicized from *Cocol-meca-xihuitl*. This phrase is in turn abbreviated from *cocoltic*, 'twisted,' *mecatl*, 'rope,' and *xihuitl*, 'herb,' and refers to the twisted appearance of the plant's stem or shoot (Robelo, 1977). Although *Phaseolus metcalfei* vines and roots could be considered rope-like, the description was probably intended for *Smilax* species instead.

The Nahuatl language was the lingua franca in Mexico during late prehistoric and early historic times, and was utilized by herb and mineral merchants trading as far north as the New Mexican pueblos (Riley, 1974, 1975). It is possible that the spread of the term cocolmeca, and its adoption for reference to *Phaseolus* roots, was facilitated by cross-cultural herb trade by Nahuatl speakers.

A second hypothesis for the origin of cocolmeca comes from Padre Juan Nentuig, a Jesuit missionary stationed near the present-day Arizona-Sonora border in the mid-1700s. Nentuig wrote that *cocolmecate* is a word from the Opata Indians, the Cahitan-speaking people of eastern Sonora. He suggests that the term reflects the Opata's esteem for the curative power of the plant, for *cocomecara menas*, 'be off, pain!' (Smith, 1951) or *lejos de dolor*, 'far away from pain' (Nentuig, 1971). In this case, the described plant is undoubtedly a *Phaseolus*, with long creeping vines extending over rocks. Linguist Manuel Monteverde also accepts a similar Opata etymology for the origin of the word cocolmeca (Sobarzo, 1966). It is known that this is one of the northern Mexican medicinal plants promoted by Jesuit nurse practitioner John Steinefer, whose 1711 *Florilegio Medicinal* served as the medical manual for Nentuig and other missionaries in the region (Kay, 1977). The widespread use of Steinefer's herbal in Sonora and Chihuahua likely led to a standardized name and usage for particular medicinal plants, such as the *P. metcalfei* group.

Other folk names for these species persist. In Onavas, Sonora, a Pima Bajo Indian informant said that cocolmeca was called *Sha'i bav*, '(tepary) bean of the brush,' in Piman, which he translated into Spanish as *tepari del monte* (Dr. Amadeo Rea, personal communication). Pennington's (1963) ethnobotany of Chihuahua's Tarahumara Indians records *gotoko* as the native name for *P. metcalfei*,

as does Thord-Gray (1955). Pennington also records two Hispanic-American names for the same plant: *frijolillo,* 'little bean,' a diminutive used in northern Mexico for several wild legumes, and *corcomeca,* a variant of cocolmeca. Today in Chihuahua and Sonora, mestizos know the same *P. metcalfei* plant by these two names: frijolillo, for the beans; and cocolmeca for the medicinal root (Fig. 3). Thus use has a great deal to do with what a plant is called.

USE AS FOOD

The pods and seed of the *P. metcalfei* group have long been used as a human food, yet the cultural significance of this use is difficult to evaluate. Very few references identify which particular Indian groups utilized these beans. Considerable cultural information may have been obscured by the course of history in the Southwest. Let us first consider the available information on the palatability of these beans.

There are conflicting reports on the value of *P. metcalfei* as a green pod bean and a dry bean. Harvard (1885) noted that "the seeds . . . are about the size of peas; when still green and well cooked they made an acceptable dish in the field. When ripe they are too tough for use." Rusby (1906) also felt that the beans are more tender and agreeable before ripening, but noted that they are not beyond use even when tough. Goodding (1946) reports that the relatively rare Metcalf beans "are as large as large peas and are delicious to eat, though it is true that you might well starve while gathering a mess, rodent competition is too keen."

Pennington (1963) records that the Tarahumara harvest the seed of the ubiquitous *P. metcalfei,* and prepare them in one of two ways. They are either parched and then eaten, or ground, and mixed with a maize-based *atole* gruel. These preparation methods, parching, and grinding for consumption in gruels, are customary for both wild and cultivated beans throughout Southwestern Indian communities (Nabhan and Felger, 1978). The consumption of *P. metcalfei* beans, however, does not seem to be prevalent amoung the Tarahumara today. Dr. Robert Bye (personal communication) has recently been informed by Tarahumara that the beans are not good as food. Additionally, neighboring culture groups of the same foods reply negatively to inquiries regarding *P. metcalfei* as a food (Pennington, 1969; Nabhan and Sheridan, 1976 field notes). It appears unlikely that wild beans have been a major food resource for those Uto-Aztecan-speaking peoples within this century.

The wild bean story for Athabaskan-speaking peoples in the Southwest, particularly the western Apache, is even more fragmentary. Kearney and Peebles (1960) assert that for *P. metcalfei,* "the beans of this and probably other species were eaten by the Apache Indians." Kephart (1917) noted that wild *Phaseolus* beans were eaten by the Apache when green or dried. Palmer (1871) similarly reported that Apache near Fort Whipple, Arizona, harvest a large *Phaseolus* bean from the mountains nearby, and eat it green or dried. Palmer's comment that this wild bean has a large, easily cultivated perennial root indicates that it may have been *P. metcalfei,* which occurs in the area. Reverend Paul S. Mayerhoff collected *P. metcalfei* at Fort Apache in 1901, as part of his "Plants of the Apache" survey, but did not clarify the nature of its use (Mayerhoff, FM!). Rusby's (1906) notes on Southwestern Indian use of *P. retusus* (=*P. metcalfei*)

may have included data from the Apache, since he did derive some ethnobotanical information from them. In 1880, he collected a specimen of this plant in the Burro Mountains near the Arizona-New Mexico border, then considered "Apache country" (Rusby 107, FM!).

These clues to western Apache use become more cogent in the context of the historic subsistence ecology of these peoples. In particular, there are remarkable positive correlations between western Apache and *P. metcalfei* in terms of 1) geographic range, 2) habitat preferences, and 3) seasonal pulses of activity.

The geographic overlap between this culture group and *P. metcalfei* is evident. Specimens are available for bean populations from several localities that the western Apache traditionally frequented: the White Mountains, Chiricuahuas and Huachucas in Arizona, and the Pinos Altos, Mogollon, Burros and Mangas Springs areas in New Mexico.

More important than geographic range, however, is habitat preference and ecological niche. Basehart (1959) directs attention to "two important features of Chiricahua (Apache) subsistence: 1) the significance of wild plant products which were capable of preservation and storage; 2) the primary dependence of the Chiricahua on the Pinon-Juniper zone."

The Pinon-Juniper zone, within the historic range of the Chiricahua, extends from roughly 1,100–1,900 m, nearly the same elevational range as *P. metcalfei*. Within this zone, mescal (*Agave parryi*) has been considered to be one of the most important staple food plants for the Chiricahuas (Basehart, 1959; Castetter and Opler, 1937). It occurs sympatrically with *P. metcalfei* in several places (e.g., Nabhan 734 and 740, ARIZ).

P. metcalfei is similar to mescal in that it also meets Basehart's first guideline for Apache subsistence foods; dry beans are quite storable. Rusby (1906) records that Indians gathered them "in large quantities for winter use."

Although such plant populations might be highly localized and widely separated, historic Apache social organization was uniquely adapted to exploiting such resources over a large home range. Basehart (1959) concludes that for the Chiricahua Apache, "given sufficient territory and mobility . . . , it was possible to locate a more productive area and move rapidly to take advantage of its resources." Their social groups were flexible enough to permit splitting up if plant resources were small and separated, or to gather together if a bumper crop occurred in one area. They usually frequented the uplands during summer and autumn, and were adept at exploiting quick pulses of plant productivity whenever this occurred.

It is notable that early ethnobotanical reports suggest Apache use of *P. metcalfei,* but later field workers (Reagan, 1929; Castetter and Opler, 1937; Buskirk, 1949) do not mention the Apache knowledge of these beans. These later ethnobotanical works were written decades after the western Apache had become more sedentary, when the range and fluidity of Apache gathering activities were drastically reduced. Thus any food importance which *P. metcalfei* had formerly may have been diminished in the late 1800s when the Apaches were defeated and their migratory subsistence patterns were broken.

Another hypothesis also allows the possibility that *P. metcalfei* beans were utilized to a greater degree prior to the late 1800s. The impact of livestock introductions on native food plant populations has been carefully examined by Bohrer

(1975a,b). Bohrer suggests that grazing pressure drastically reduced the abundance of certain wild species which were of cultural significance in prehistoric and early historic times. Today, only localized relic populations remain of such species, usually in areas relatively inaccessible to livestock.

Wooten and Standley (1913) promoted *P. metcalfei* vines as a forage crop because of their palatability for cattle. Curiously, Harvard (1885) considered *P. retusus* (=*P. metcalfei*) to be "common on prairies west of the Pecos." Today, it occurs only infrequently in west Texas, largely on steep rocky slopes inaccessible to cattle. Rusby (1906) said the plant was "especially abundant in Central Arizona," and that the Indians could gather large quantities of beans. Again, the only sizeable populations we have seen in Arizona are on steep slopes, and certainly aren't extensive enough for the plant to be termed "abundant" today. Goodding (1946) considered both *P. metcalfei* and *P. ritensis* to be relatively rare. Has grazing pressure decreased the frequency and abundance of the edible vines of the *P. metcalfei* group, particularly in open, more accessible environments?

The one probable occurrence of *P. metcalfei* in the archaeological record adds to the mystery regarding historic changes in this plant's distribution. Beans reported as "possibly of *Phaseolus metcalfei*" were excavated from cremations at Gila Bend, Arizona, with Tanque Verde cultural material from about 1,200–1,300 A.D. (Greenleaf, 1975). Dr. J. C. Greenleaf (personal communication) has verified that the *P. metcalfei* identification is correct, although the specimens cannot be located. Since Gila Bend may be as much as 125 km from the nearest known extant population of *P. metcalfei*, two hypotheses can be proposed to account for the beans at Gila Bend: 1) they were collected far away from the site, and brought back due to their special significance as a food or ceremonial item; 2) the plants once grew near Gila Bend, and were a usual food in the area.

In summary, it is evident that the use of wild beans as food was far more intensive and extensive prior to this century. Both cultural and environmental changes likely contributed to the abandonment of their use. It is impossible to say to what extent *P. metcalfei* and *P. ritensis* contributed to meeting the nutritional needs of their gatherers. However, Rusby's (1906) comment that these beans were the only herbaceous legumes in the Southwest to be harvested extensively for seed suggests that they provided a protein source to upland dwellers which scientists have previously underestimated.

MEDICINAL USES

By the 1790s, European observers were impressed by the medicinal use of *Phaseolus* by native Sonorans (Nentuig, 1971):

> . . . it has a red root, which when boiled and drunk, relieves pain in the stomach, clears away obstructions, and serves the women in the flow of menses. It is also given as an ordinary drink to the sick.

This use and others were probably pre-Columbian, and abstracted in Steinefer (Kay, 1977). Today, nearly the same terms are used by Sonorans to describe the value of these roots. In the Sierra Madrean uplands of northern Mexico, curanderas—the female practitioners of folk medicine—preserve the tradition of co-

colmeca use in small villages. Additionally, commercial herbalists now sell the roots in urban markets and at religious festivals (Fig. 5, 6). While *P. metcalfei* seed consumption has diminished historically, the use of the root has probably increased in both scale and range.

Our knowledge of Indian uses of the root comes primarily from Sierra Madrean groups. The southeastern Tarahumara prepare a drink from the root to alleviate stomach upsets (Pennington, 1963). The Pima Bajo of Sonora used it primarily to cleanse the blood (Dr. Amadeo Rea, personal communication). The Mountain Pima of Yepachic, Chihuahua, prepare a purgative from the roots, as well as a refreshing drink which overcomes drowsiness (Pennington, 1973). Farther north, the Navajo in southeastern Utah reportedly use the root when castrating sheep (Phyllis Hogan, personal communication).

The roots are also used and sold by mestizos and chicanos, the Spanish-speaking, genetically mixed peoples of northern Mexico and the Southwest. The range of ailments for which mestizos utilize *P. metcalfei* roots is similar to that of other cocolmecas (e.g., *Smilax* and *Salix*), as they are reported in literature on Mexican folk medicines (Hicks, 1966; Martinez, 1969; Riley and Trujillo, 1956; Winter, 1968). It is believed by some Mexicans that pregnant women should avoid cocolmeca (Hicks, 1966).

The following list of uses was recorded verbatim from seven mestizo herb vendors at the 1977 feast of Saint Francis in Magdalena, Sonora, Mexico (Fig. 6, 7). This fiesta attracts thousands of mestizos from both sides of the international border, as well as Pima, Papago, Yaqui and Mayo Indians. It is a major cross-cultural herbal exchange, supplying folk medicines to people otherwise isolated from such outlets. The list gives the translations of verbatim descriptions, as well as the number of times each use was mentioned (in parentheses). Tea from *P. metcalfei* roots is said to be used a) for digestion (2); b) for purifying the blood (3); c) for the kidneys (2); d) for losing weight without dieting (2); e) as a diuretic (2); and f) for the wind in the stomach (1).

In general, all herbs sold under the name of cocolmeca are used principally for stomach or blood (including menstrual disorders). The association of the red roots with blood may be as much or more symbolic than functional. Tea-like drinks from *P. metcalfei* do appear to function as a diuretic (Dr. Andrew Weil, 1978 personal communication) and may affect digestion and loss of body water to some degree. The potential medicinal value of the *P. metcalfei* root should not be dismissed. Whether pharmacologically investigated or not, it will likely continue to be a prominent part of the medicine cabinet in traditional Southwestern communities for some time to come.

USE AS A FERMENTING AGENT

Throughout southwestern North America, native peoples have made beverages from fermented maize, fruit and century plants for centuries. The undistilled fermented drinks were often referred to generically as *tesguinos* or *tiswines*, terms of Mediterranean origin introduced by the Spanish to the Americans. Generally comparable to beers in terms of alcohol content, tesguinos fermented from sprouted maize have considerable nutritive value; this fact has long been overlooked by mission-oriented outsiders (Dr. Robert Bye, personal communication).

We will restrict our discussion here to the use of *Phaseolus* roots and other plants in the preparation of tesguinos. The famous explorer Carl Lumholtz (1902) was the first scientist to describe the use of *Phaseolus* roots in native brewing: "When the Tarahumares want to made maguey (century plant) wine, they leave the baked stalks in water in natural hollows or pockets in rocks, without any covering. The root of a certain plant called *frijolillo* is added as a ferment, after two days the juice is wrung out with a blanket." Lumholtz regarded maize tesguino as a nourishing and medicinally beneficial beverage, noting that "nothing is so close to the heart of the Tarahumara as this liquor . . . ."

Pennington (1963) lists the pounded roots of *Phaseolus metcalfei* among the products of at least fifteen plant species utilized by the Tarahumara in tesguino preparation. He considers it to be one of the preferred fermenting agents in making century plant and peach tesguino, and the most common catalyst in maize tesguino in eastern Tarahumara country. Thord-Gray (1955) considered these bean roots to be a necessary ingredient of *pachi-ki*, 'maize-stalk tesguino,' and *chaw-ki*, 'century plant tesguino.' He notes that it can either be pounded or ground on a *metate*, 'grindingstone,' before its addition to the brew.

The Tarahumara are not the only people who utilize *Phaseolus* roots in tesguino-making. Gentry (1963) reports that the Warihio Indians, Sierre Madrean neighbors of the Tarahumara, utilize *P. caracalla* and *P. metcalfei* roots as catalysts for century plant tesguino. Gentry's voucher specimens of the root from Sierra Canelo, Chihuahua, note that they are used in making fermented *batari*, 'century plant' beverages. These specimens have since been reidentified as *P. ritensis*, not *P. metcalfei* (Gentry 2523, ARIZ!; see note on the duplicate at Harvard, in Altschul, 1973). Reagan (1929) notes that "various perennial weeds and roots are added" to the western Apache *tulapai* beverage, although *Phaseolus* roots are not specified. There is also reference to cocolmeca utilized in the preparation of a grain and sugar beverage, called *popo*, from Vera Cruz, Mexico (Rodriguez Beltran, 1902; Santamaria, 1974).

Pennington (1963) notes that Tarahumara informants observe the addition of roots to pottery vessels of tesguino only in terms of making the drink "strong." The Warihio say that *Phaseolus* roots cause the liquid to "boil"; after a day or so, the bubbling stops and the beverage is ripe for drinking (Gentry, 1963). It is easily demonstrated that *Phaseolus metcalfei* roots added to heated water increase the magnitude of bubbling. How this bubbling activity relates to the fermentation is not empirically understood. A bacterium, *Bacillus megaterium*, and a yeast, *Saccharomyces cerevisiae*, have been isolated from Tarahumara tesguinos prepared with *P. metcalfei* (Herrera and Ulloa, 1973; Ulloa et al., 1974); unprepared *Phaseolus* roots should be examined for the possible presence of these organisms active in the fermentation process.

OTHER USES

Pennington (1963) reports that the Tarahumara utilize *P. metcalfei* roots in the preparation of a glue used to mend household utensils. *Phaseolus* roots are added to water, and boiled down until most of the liquid is dissipated. When cooled, the thick residue is applied as a mending glue to cracks in dippers and containers made from the bottle gourd, *Lagenaria siceraria*.

Fig. 8. Leslie Goodding's experimental rows of *Phaseolus metcalfei* at Soil Conservation Service plots, Albuquerque, New Mexico, in the 1930s.

Around the turn of the century, J. K. Metcalfe of Mangas Springs, New Mexico, brought *P. metcalfei* (then known as *P. retusus*) into cultivation as a livestock food. Metcalfe may have learned of the plant's usefulness from the Mimbreno Apache who occasionally helped him at Mangas Springs, according to his granddaughter (Mrs. Foster, 1977 personal communication). His son, O. B. Metcalfe, became a range scientist and made some of the most significant collections of these beans in New Mexico.

Wooten and Standley (1913) renamed the plant *P. metcalfei* in honor of J. K. Metcalfe, and noted that "the crop which can be produced on an acre of ground is a large one." It appears to have been briefly cultivated elsewhere in the Southwest too, and discussed in United States Department of Agriculture publications as a valuable forage crop (Wooten and Standley, 1915). Leslie Goodding brought *P. metcalfei* into cultivation at United States Soil Conservation Service experimental plots in Albuquerque, New Mexico, in the 1930s (Fig. 8). Goodding (1938) reported that the *P. metcalfei* group "forms almost a solid ground cover and, while the stems do not root, the prostrate vines prevent erosion quite effectively. It is not at all improbable that this plant with proper selection and possibly proper breeding could be made not only useful as an erosion control and forage plant, but even for the production of very palatable beans for human consumption." Nabhan (1975) urged evaluation of *P. metcalfei* and *P. ritensis* as cultivated human foods and forages in the upland Southwest. Recently, Theisen et al. (1978) have included these *Phaseolus* species in a compendium of potential food crops better adapted to environmental stress than conventional crops. To date, how-

TABLE 3. CHEMICAL ANALYSES OF WILD BEAN SEEDS FROM THE U.S. SOUTHWEST.

Species	Locality	Collection	Moisture %	Crude fat %	Crude protein %
P. metcalfei	New Mexico: Gila Hot Springs, Gila Cliff Ruins. 1,870 m	Nabhan 735	6.7	1.30	20.5
P. metcalfei	New Mexico: Pinos Altos Loop Road. 2,610 m	Nabhan 734	5.5	0.80	26.0
P. metcalfei	Texas: Davis Mt., Point of Rocks Rest Area. 1,800 m	Nabhan 688	4.5	0.60	27.7
P. ritensis	Arizona: near Ruby, Sycamore Canyon on Mexico border. 1,600 m	Nabhan 661	4.8	0.65	30.9

ever, seed supplies have been so limited that only small experimental plots of these species have been cultivated during this decade; no commercial plantings are known.

CHEMICAL ANALYSES

Chemical analyses of seeds of *P. metcalfei* and *P. ritensis* are listed in Table 3. Seed samples were ground in a Wiley mill using a 40 mesh screen. A crude protein value for each sample was obtained by the micro Kjeldahl method (conversion factor was 6.25); the average of duplicate analyses is reported.

The data in Table 3 indicate that the *P. ritensis* sample had a much higher protein content than the three *P. metcalfei* collections. The *P. ritensis* sample also had smaller, lighter seeds than the other three. The range in protein contents noted in Table 3 is generally the same as that reported for *Phaseolus acutifolius* in Nabhan and Felger (1978).

Additional seed samples for wild populations should be both conserved and screened for protein content and other nutritionally significant characters. We are currently investigating the chemical composition of the roots, but know of no other previous or current chemical studies of the seed, foliage or roots. Such analyses should be integrated into the wild germ plasm evaluation program prior to any selection or breeding.

CONCLUSIONS

Phaseolus metcalfei and *P. ritensis* have had a rich history of use in southwestern North America. The protein content of their seeds is high enough to have made them a nutritious component of the diets of the region's historic Indians. The consumption of these seed probably diminished quickly between 1880 and 1900, when Indian subsistence patterns changed, and environmental conditions favoring these plants eroded rapidly. The roots of both species have been utilized as fermenting agents in the preparation of tesguinos, the indigenous fermented beverages of southwestern North America. The roots have also served as folk medicines for natives of the region for no less than 200 years. As a multiproduct plant, *P. metcalfei* has some potential as a new crop for arid and semiarid lands.

In surveying wild plants for their potential development as economic crops,

attention should be directed not only to their current use, but to their historic uses by natives of the region. The importance of *P. metcalfei* was obscured until older publications and native peoples in more traditional localities were consulted. It then became clear that it is the only leguminous herb providing seed which was eaten on an extensive scale in the Southwest (Rusby, 1906), and that it has long been a respected medicine (Kay, 1977). Finally, chemical analyses of the plants can be a definite aid to the economic botanist in evaluating such plants and placing native uses in perspective.

Recent interest in the agronomic potential of perennial relatives of domesticated annuals has been high. If perennials such as wild gourds (*Cucurbita foetidissima*), Jalisco teosinte (*Zea diploperennis*), and cocolmeca (*Phaseolus metcalfei* and *P. ritensis*) can be successfully brought into cultivation, human kind may have much to gain. A perennial agro-ecosystem based on hardy, nutritious crops would reduce the energy costs and soil degradation associated with frequent tillage. Since much is already known about the genetics and breeding of maize (*Zea*), squashes (*Cucurbita*) and beans (*Phaseolus*), breeders have a wealth of analogous experiences to draw upon in directing the development of these potential crops.

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